

**PHYTOTOXICOLOGY ASSESSMENT
SURVEY
IN THE VICINITY OF THE
SHELL, PETROCANADA AND
IMPERIAL OIL PETROLEUM
TANK FARMS, TORONTO
1991**

MARCH 1993

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**Ministry of
Environment
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ARB-251-92-Phyto**

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BACKGROUND and INTRODUCTION

In August 1991, Health and Welfare Canada (HWC) investigators expressed concerns that vegetables grown and sold from a market garden in the City of North York were being contaminated by adjacent petroleum storage tank 'farms'. The tank farms and adjacent agricultural fields are located near the intersection of Keele Street and Finch Avenue and are owned by Imperial Oil, PetroCanada and Shell. The field sections of these properties total approximately 30 ha in size and were leased from the respective corporate owners by Gino Greco. These fields were used to grow a variety of produce crops in a pick-your-own and roadside retail operation. Crops included tomato, zucchini, eggplant, rappini, pumpkin, peppers and cabbage.

Mr. Stefan Krywenkyj, a drug inspector with HWC, was concerned that organic and inorganic contaminants from the storage tanks could possibly leach into soils and be taken up by vegetables in the area. These concerns were relayed to Andrew Zegota at the Health Protection Branch of HWC and subsequently to Pearl Shore of the Toronto West District Ministry of the Environment (MOE) Office. The Phytotoxicology Section was asked by the Toronto MOE office to investigate HWC's concerns relating to soil and vegetation contamination.

METHODOLOGY

All field activities were conducted by the author on September 23, 1991. Initial visual surveys of the crops and near surface soils were conducted prior to sampling.

Composite soil samples were collected from a number of sampling sites within each of the agricultural blocks (Shell, PetroCanada and Imperial). Sample sites were selected to be increasingly distant from the petroleum storage areas and to represent the diversity of crop types within each agricultural block. The attached figure illustrates the distribution of sampling locations relative to the tank farms and crop plantings.

Table 1 summarizes the soil sampling that was conducted at each sampling station. Composite soil samples were collected in duplicate from 12 sampling stations to normal cultivating depth (0-15 cm). Nine (9) of the soil sampling stations were also sampled in duplicate to a depth of 0.75 m. Near surface (0-15 cm) composite samples consisted of at least 50 individual core sections collected from random locations within the area and extracted using a 2 cm - diameter stainless steel soil corer. Depth samples were obtained by excavating to a depth of 0.75 m using a power auger, removing excess soil from the excavation and obtaining at least 20 individual core sections (10 cm) from the bottom of the excavation using a 2 cm - diameter stainless steel soil corer. The upper 5 cm of each core was discarded to avoid the possibility of cross contamination due to the spiral motion of the

auger. Soil samples collected for inorganic analysis were stored in plastic bags and those collected for organic analysis were stored in amber glass bottles.

Table 1 also summarizes the vegetation sampling that was conducted at each sampling station. Produce samples were collected in duplicate from the majority of soil sampling locations. Additional sample stations for vegetation collection were also established in close proximity to the soil stations when additional species coverage was required. Vegetation samples were collected in duplicate using shears. Foliar samples consisted of at least 100 leaves collected from a minimum of 25 plants that were selected at random within the area. Fruit samples consisted of a number of individual fruit samples (the number depending on the size of the fruits) collected from randomly selected plants. Vegetation samples collected for inorganic analysis were stored in plastic bags and those collected for organic analysis were stored in amber glass bottles.

Soil and vegetation samples collected for inorganic analysis were dried and processed. Vegetation samples were oven-dried, ground in a Wiley-mill and stored in glass bottles. Soil samples were air-dried, pulverized to pass through a 45 mesh sieve and stored in glass bottles. The prepared samples were then forwarded to the Ministry of the Environment laboratory on Resources Road, Rexdale for total lead analysis.

Soil and vegetation samples collected for organic analysis were stored frozen (-85°C) and were not further processed prior to analysis. Samples were analyzed for volatile organics and petroleum distillates. These compounds were as follows:

TRI-1,2-DICHLOROETHYLENE	ETHYLBENZENE
1,1-DICHLORETHANE	M- AND P-XYLENES
CHLOROFORM	BROMOFORM
1,1,1-TRICHLOROETHANE	O-XYLENE
CARBON TETRACHLORIDE	1,1,2,2-TETRACHLOROETHANE
BENZENE	1,4-DICHLOROBENZENE
1,2-DICHLOROPROPANE	1,3-DICHLOROBENZENE
TOLUENE	1,2-DICHLOROBENZENE
1,1,2-TRICHLOROETHANE	BRCL ₂ CH+TRICHLOROETHYLENE
CHLOROBENZENE	TETRACHLOROETHYLENE+CLBR

RESULTS AND DISCUSSION

There were no obvious signs of vegetation damage or reduced growth exclusive to areas of the fields close to the petroleum storage areas. However, it should be pointed out that a systematic assessment of growth rates and/or mortality was beyond the scope of this study. There were areas within the field that had lower rates of plant growth and where the plants were more chlorotic.

However, these areas were not restricted to areas near the storage tanks and, in the opinion of the author, were not unusual for plantings of this size and crop diversity. Similarly, field examination of soils did not indicate that there had been any near surface discharges of petroleum to the fields as evidenced by soil staining and/or soil odour.

Table 2 summarizes the results of crop and soil lead chemistry. The results of the lead analysis revealed that crop foliage and fruits collected from the agricultural fields were not contaminated by lead. While produce collected from the ESSO portion of the fields did have slightly elevated concentrations of lead as compared to produce collected from the other fields, the concentrations of lead in produce from all fields were well below the ULN guidelines (MOE, 1989). In addition, there were no consistent patterns of elevated lead concentrations in vegetation samples collected close to the storage areas compared to those collected distant from the facilities. The vegetation ULNs were developed primarily for comparison with tree foliage, therefore they may not accurately reflect the background range of lead in crop foliage and roots. However, they would reflect how vascular plants respond to lead uptake and therefore they are useful as a relative comparison. Vegetables grown in soil with lead concentrations below 500 ug/g are generally considered to pose minimal risk to individuals consuming thoroughly washed produce (Appendix II). It is, however, important to note that, while concentrations of lead found in this study were very low by urban standards, any exposure to lead poses some degree of risk, with children being especially susceptible to exposure.

Similarly, soil samples collected from these agricultural fields had lead concentrations which were well below the ULN guideline for lead in an urban or rural environment. The mean lead concentration for all sites was 14 ug/g compared with the ULN for lead of 500 ug/g. The slightly elevated concentrations of lead in produce collected from the ESSO fields was not reflected in soil lead concentrations and may have been the result of natural variability and/or other urban airborne lead sources. The concentrations of lead in soil collected in close proximity to the Shell and ESSO facilities (Sites 4 and 13, respectively) were marginally elevated compared with samples collected distant from the facilities. However, lead concentrations of 17 and 19 ug/g, respectively, are considered very low by urban or rural standards and it was not considered probable that the storage facilities contributed to these lead levels. It was more probable that vehicular traffic along Keele Street and associated historical general urban lead loadings had influenced these westerly stations.

The concentrations of volatile organics and petroleum distillates in soil and vegetation samples were determined to be essentially zero for all samples and all parameters tested. This includes soil samples collected below the cultivation depth at 0.75 m. The detection limit for the organic compounds tested was 20 ug/kg and all samples had concentrations below this limit.

Therefore, based on soil and vegetation analysis, it can be concluded that soils in the agricultural fields east of the petroleum storage facilities are not contaminated (for the parameters tested) and should be suitable for use in the current agricultural capacity.

SUMMARY

Inspectors with HWC were concerned that organic and inorganic contaminants from petroleum storage tanks in the Keele and Finch area could leach into soils and be taken up by market vegetables grown in the adjacent fields. The Phytotoxicology Section was asked by the Toronto MOE office to investigate HWC's concerns relating to soil and vegetation contamination and to assess the suitability of these fields for crop production for human consumption. Visual and chemical analysis (lead, volatile organics and petroleum distillates) of vegetation and soils did not indicate any impact of the petroleum storage tank farms on the adjacent agricultural fields. Subsequently, the fields should be considered suitable for use in the current agricultural capacity without restriction.

REFERENCES

Ontario Ministry of the Environment. 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples - March 1989. ARB-138-88-PHYTO. Phytotoxicology Section -Air Resources Branch. Ontario Ministry of the Environment.

Sketch map of sampling sites in the vicinity of Shell, PetroCanada and Imperial Oil petroleum tank farms, Toronto - 1991.

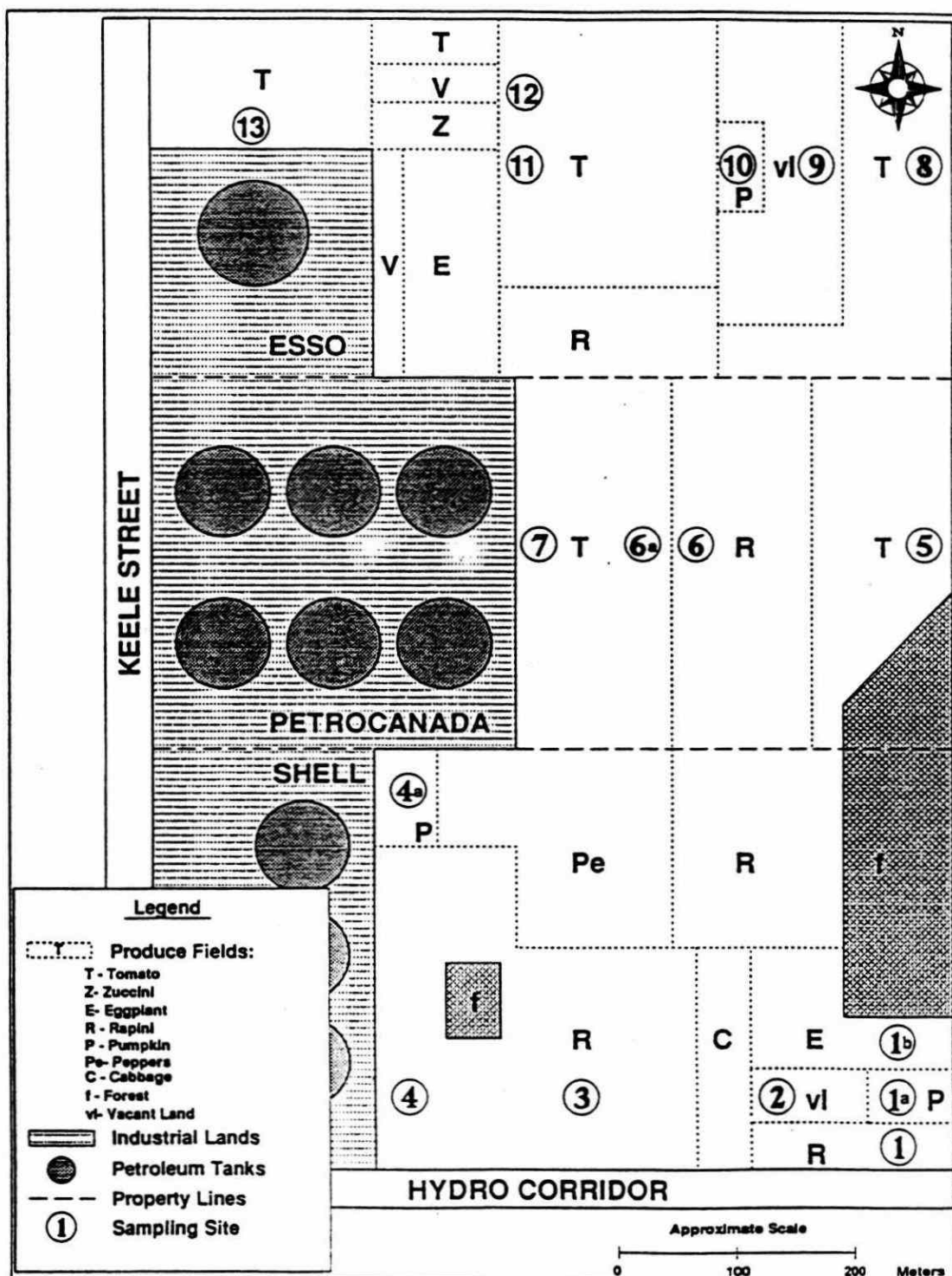


Table 1: Soil and vegetation samples collected from sampling sites.

SITE	SOIL DEPTH (cm)		CROP SPECIES ^{3,4}			
	0-15 ¹	75 ²	Eggplant	Pumpkin	Rappini	Tomato
1	X	X			X	
1a				X		
1b			X			
2	X	X				
3	X		X		X	
4	X	X			X	
4a				X		
5	X	X				X
6	X					X
6a					X	
7	X	X				X
8	X	X				X
9	X	X				
10				X		
11	X	X				X
11a					X	
12	X					X
13	X	X				X

¹ Near-surface soil samples submitted for lead, volatile organic compounds and petroleum distillates.

² Sub-surface soil samples submitted for volatile organic compounds and petroleum distillates.

³ Vegetation samples submitted for lead, volatile organic compounds and petroleum distillates.

⁴ Fruits submitted for chemical analysis except for leaves of rappini.

Table 2: Lead concentrations in soil and vegetation samples collected from sampling sites.

SITE	SOIL LEAD CONCENTRATION (ug/g)	CROP SPECIES ¹			
	0-15 cm	Eggplant	Pumpkin	Rappini	Tomato
1	15			1.9<T	
1a			0.7<T		
1b		0.8<T			
2	13				
3	11	<0.5<W		0.9<T	
4	19			1.3	
4a			<0.5<W		
5	12				0.5<W
6	13				3.2
6a				4.9	
7	12				1.9
8	13				3.3
9	11				
10			3.8		
11	13				3.1
11a				4.7	
12	14				2.6
13	17				4.6
ULN ²	500, 150 ³	60, 30, 20 ⁴			

¹ Fruits submitted for chemical analysis except for leaves of rappini.

² Upper Limit of Normal contaminant guidelines (ug/g dry weight) of lead in soil and vegetation. The guidelines are approximately equal to the mean of the data plus three standard deviations (see Appendix I).

³ Soil ULNs developed for urban and rural soils (0-5 cm), respectively.

⁴ Vegetation ULNs developed for urban and rural foliage and rural grass, respectively.

APPENDIX I

Derivation and Significance of the MOE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a point source of pollution. Urban ULN guidelines are based on samples collected from developed urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (ref: Ontario Ministry of the Environment 1983, Phytotoxicology Field Investigation Manual). Chemical analyses were conducted by the MOE Laboratory Services Branch.

The ULN is the arithmetic mean, plus three standard deviations of the mean, of the suitable background data. This represents 99% of the sample population. This means that for every 100 samples which have not been exposed to a point source of pollution, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.

APPENDIX II

Soil Lead Information *

Lead is not necessary for normal body function (iron is an example of an essential dietary nutrient). Recent studies have suggested that there may be some risk at very low levels of exposure. Lead in the environment can come from many sources, such as industrial emissions, vehicle exhaust, and peeling or flaking paint. Therefore, people are exposed daily to small amounts of lead. Young children and the developing fetus are the most sensitive to the toxic effects of lead. Environmental lead concentrations are usually much higher in urban areas. Soil contaminated with lead also may be contaminated with other elements, such as zinc, cadmium, arsenic, and antimony. This information sheet deals only with lead.

The experimental data developed by the Phytotoxicology Section of the Air Resources Branch, and the scientific literature, suggest that some vegetables will take up lead from the soil. Generally, the amount of accumulated lead is greatest in roots (eg. beet, carrot, onion, potato, radish), lower in stems and leaves (eg. celery, chard, lettuce, cabbage), and lowest in fruit (eg. tomatoes, berries, apples, bean, cucumber). The amount of lead that accumulates in the vegetables depends on the kind of vegetables grown, the soil characteristics, the garden management practices, and the soil lead concentration. The lead concentration in vegetables increases with plant age. It is generally accepted that there is minimal risk in consuming vegetables grown in soil with a lead concentration below 500 parts per million (ppm). The following table is a guide for planting and eating vegetables in soil with varying lead concentrations.

Guide for Planting and Consuming Vegetables

Soil Lead Concentration Parts Per Million	Root	Leaf ¹	Fruit
1 - 500	M	M	M
501 - 1000	R	M	M
1001 - 1500	A	R	R
greater than 1500	A	A	A

M - minimal risk (wash thoroughly)

R - reduced consumption (wash thoroughly)

A - avoid consumption/avoid planting

¹ - lettuce may accumulate lead more readily than other leafy produce

To minimize soil and vegetable lead contamination always locate vegetable gardens away from roadways, driveways, downspouts and sources of flaking or peeling paint. All vegetables should be thoroughly washed before consumption. The above table is only a guide; consuming vegetables grown in lead contaminated soil increases the exposure to environmental lead and is at the home owner's risk.

Children will ingest soil while playing. Recent medical evidence has determined that children under six years old will develop elevated blood lead levels by playing in soil with lead concentrations of 1,000 ppm and higher. Because the child's blood lead level is related to their total environmental lead exposure, the relationship between soil lead and blood lead is not precise. Therefore, where other potential lead sources exist, there may be some risk to children exposed to soil with lead concentrations below 1,000 ppm. Elevated blood lead levels in children inhibits enzyme activity in red blood cells, impairs vitamin D synthesis in the kidney, and impairs normal neurobehavioral development. More serious effects can occur at higher environmental lead exposure.

To minimize lead exposure to young children, access to lead contaminated soil should be restricted and the child's hands should be thoroughly washed after playing outdoors. Lead exposure from soil can be substantially reduced by removing the contaminated soil (three to six inches is usually sufficient), covering it with clean soil and sod, or covering it entirely with a solid material such as pavement, paving stone or wood. The home owner should contact a local Environment Ministry official for advice regarding the disposal of soil with high lead concentrations. Concerns about personal lead exposure should be discussed with a doctor.



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